about his domestic relations—possibly not understood by many of his foreign admirers and friends. Married late in life—and even in his very youth never having had much place in his mind for love—still his agreeable and quiet character, his inexhaustible kindness, his open frank cordiality, which so often secured the sympathy of others, seemed to promise an abiding union between him and his wife, but the liberal ideas of the husband, and his devotion to his very peculiar studies, did not please Madame Bernard. The state of things became irritable—intolerable; even the birth of two children did not improve the condition of affairs. In 1869 the separation came. The husband and the father was left alone; and from then to the end of his days he lived his solitary life in an apartment in the rue des Écoles, *vis à vis* to the College of France. His life was all too full of work to leave much time for a morbid appreciation of his solitude. Some slight rest was taken each year at the vintage period at Saint Julien, near Villefranche, and he almost every year took part in the French Association for the Advancement of Science, an Association which he assisted in founding, and of which he was the first president. During these latter ten years Bellesme was his very constant visitor, his trusty friend. They were times not to be recalled, he tells us, without emotion, and he regards them as among the happiest of his life. Often he would spend the evening with him by his fire-side in the small bedroom, where by preference he would pass the afternoon, and which his old servant would keep with a quite canonical neatness. In the background was the bed with its curtains of blue damask, to the left the fireplace; at the side of the bed, a large armchair in which Claude Bernard would sit enveloped in a dressing-gown, which, on his ample shoulders, took the folds and plaits of an ancient toga; his head covered with a cap, which he would often remove while talking, with an action peculiar to him, as if his thoughts made him find it too tight. Close to him, opposite the fire, a small square table, on which the lamp is placed amidst a mountain of reviews, *brochures*, new books sent to him from all parts. At this epoch of his life he read, however, but little, nor did he write much. The volumes, which were published during these last ten years, were composed of extempore lectures of his, very carefully edited. "With our feet on the fender," writes Bellesme, "our conversation would begin with the striking events of the day, but speedily we turned to physiology. This was almost the sole object of the master's thoughts. About this he would wax eloquent, and speedily we would be entering on the higher regions of the science. These were charming excursions on the very mountain-tops, with the clear light of his mind illuminating all the dark valleys." No wonder that time was little thought of, or often altogether forgotten.

Up to 1865 Claude Bernard's health was excellent. About then he was attacked by an ill-defined chronic enteritis, from which, after eighteen months, he had only recovered. After this he had some rheumatic attacks, which did not frighten his friends, as he still preserved an alas deceitful appearance of vigorous health. Still nothing seemed to presage his approaching end. Towards the last days of 1877, after passing a long morning in the damp and unhealthy laboratory of the College of France, he returned home shivering, and with a feeling of intense uneasiness. The next day nephritis set in; he kept his room, and was not disquieted as to his state, but after a few days it was evident to all that his career was run. On February 7, 1878, after a six weeks of suffering, he lost all consciousness, and expired on February 10, at half-past nine o'clock in the evening. In Claude Bernard France lost a noble son, one who cultivated science purely and disinterestedly. His works will not ever perish, and in future years they will serve as a demonstration of the excellence of the "Discours de la Méthode," and as a very sure guide towards arriving at a knowledge of truth.

E. P. W.

THE FINSBURY TECHNICAL COLLEGE

THE Finsbury Technical College and the programme of instruction which we have recently received represent a *fait accompli* of the City and Guilds of London Institute.

Judging of the education to be given in the new College from the Programme forwarded to us, we may congratulate the Council of the Institute on having steered clear of the Scylla and Charybdis which overhang the narrow channel of technical education proper. In all such educational movements, there is the danger that the teaching shall either be too exclusively of the ordinary scientific type, or, by being too distinctly practical, shall attempt to take the place of workshop instruction. Theory and practice promise to be judiciously combined in the new school, and the experiment about to be tried in Tabernacle Row is interesting not only as a new departure in education, but also as showing the effect of beginning science teaching from the practical rather than from the theoretical side, as is still so frequently the case.

During the last three years the conception of the Finsbury College has undergone considerable development, and corresponds now much more nearly to what a technical school should be than appeared probable at its inception. According to the plans published in March, 1880, in the Report to the Governors, the College was to consist in the first place of chemical and physical laboratories only. These laboratories were to be adapted to instruction in various departments of applied chemistry and physics, but no provision was made for the teaching of mechanics, drawing, or of other subjects which find a place in the new programme. Such a school would scarcely have realised the idea of a technical college properly so called, least of all a college for the instruction of artisans. It is doubtful whether many of the pupils who frequent the excellent classes of Prof. Ayrton and Prof. Armstrong are really of the artisan class, for which instruction was originally intended to be given by the City Guilds. The progress that is being made in the completion of the Central Institution at South Kensington, which is expressly intended for the education of a higher class of students, renders it the more important, in order that the two schools may not clash with one another, that the instruction at Finsbury should be not only nominally, but really, of a different grade, and adapted to the improvement of artizans and workpeople.

The programme recently published shows that provision has been made for other branches of industry besides electrical lighting and technical chemistry.

The Technical College, Finsbury, consists really of two distinct schools: a day school and an evening school. It has for its objects the education of—

(1) Persons of either sex who wish to receive a scientific and practical preparatory training for intermediate posts in industrial works.

(2) Apprentices, journeymen, and foremen who are engaged during the day-time, and who desire to receive supplementary instruction in the art practice, and in the theory and principles of science connected with the industry in which they are engaged.

(3) Pupils from middle class and other schools who are preparing for the higher scientific and technical courses of instruction to be pursued at the Central Institution.

The College therefore fulfils the functions of a finishing technical school for those entering industrial life at a comparatively early age; of a supplemental school for those already engaged in the factory or workshop; and of a preparatory school for the Central Institution.

The College embraces the following four chief departments: (1) Mathematical and Mechanical; (2) Physical; (3) Chemical; (4) Applied Art.

It is under the general direction of a principal or superintendent of studies; and the Council of the Institute

appear to have acted wisely in asking Mr. Philip Magnus, who has directed the work of the Institute up to the present time with so much ability, and whose exceptional experience of Continental technical schools renders him particularly fitting for such a position—to occupy this post, pending the completion of the Central Institution, and to carry into effect the general scheme of instruction indicated in the programme.

In the day school of the Finsbury College, pupils from middle class and higher elementary schools will have the opportunity of continuing their studies, and of preparing, at the same time, for the particular branch of industry in which they purpose to be engaged.

Such a school is a technical school in the true sense of the word, for it gives the pupil the best training he can receive for his future occupation.

The instruction is not limited to the application of one branch of science only; the future electrician is taught chemistry and mechanics, the chemist is taught mechanics and physics, the mechanician is taught physics and chemistry, and, what is almost equally important, all are taught drawing, French, German, and the manipulation of tools in the workshops.

The evening school is intended for those who are already engaged in practical work, and in this department of the College noteworthy changes have been introduced, with a view of adapting the teaching to the special requirements of artisans. To the courses of Applied Physics and Chemistry originally provided for, courses of Mechanical Engineering have been added; but besides these courses, which are adapted to the higher class of artisans, a complete syllabus of instruction has been added to the programme, suited to the requirements of the special industry of the district of Finsbury, viz. cabinet-making. To provide a systematic course of instruction for cabinet-makers it was necessary to add to the other departments of the College, a Department of Applied Art; and in order to secure a good number of students to start with, the Council affiliated to the College the City School of Art, one of the oldest art schools of the country, and appointed Mr. Brophy as head master.

Moreover, to satisfy the demand of workmen engaged in numerous small industries, the Council have arranged courses of instruction, on a more systematic basis than has been previously attempted in this country, for carpenters, joiners, metal-plate workers, bricklayers, &c., thereby supplying that popular element in the instruction provided by the City Guilds, which at first seemed likely to be wanting in their scheme of technical education.

By undertaking to admit apprentices to the evening classes at half the fees, which are small enough, charged to ordinary workmen, those who have had the direction of the work of the Institute have shown a just appreciation of the importance of encouraging apprentices of fifteen to twenty to follow the evening courses of instruction; for there will be far less difficulty in inducing youths, during their apprenticeship, to attend regular systematically-arranged lessons, covering a period of two or three years, than is generally found in the case of adult workmen.

Indeed, it is in the arrangement of systematised and progressive courses of instruction adapted to various industries and involving the application both of science and of art to the student's occupation, as well as in the practical methods of instruction adopted, that the Technical College, Finsbury, is differentiated from other science schools.

The programme of studies now before us is a publication that can hardly fail to prove useful to all persons who are interested in the establishment of technical schools, and shows unmistakably that the Council of the Institute and their advisers are fully conscious of the difficulties that beset the problem of technical education, and may be trusted to deal judiciously with them in the schools established under their direction.

The fittings of the new College, which are most complete and admirably adapted for practical teaching, have been designed and executed under the direction of Professors Armstrong, Ayrton, and Perry.

ON THE GRADUATION OF GALVANOMETERS FOR THE MEASUREMENT OF CURRENTS AND POTENTIALS IN ABSOLUTE MEASURE[1]

III.

THE determination of H and the measurement of a current in absolute units, can be effected simultaneously by the method devised by Kohlrausch, and described in the *Philosophical Magazine*, vol. xxxix. 1870. This method consists essentially in sending the current to be measured through two coils, of which all the constants are accurately known. One of these is the coil of a standard galvanometer, the other is a coil hung by a bifilar suspension, the wires of which convey the current into the coil. The latter coil rests in equilibrium when no current is passing through it, with its plane in the magnetic meridian. When a current is sent through it, it is acted on by a couple due to electro-magnetic action between the current and the horizontal component of the earth's force, which tends to set it with its plane at right angles to the magnetic meridian; and this couple is resisted by the action of the bifilar. The coil comes to rest, making a certain angle with the magnetic meridian, and as the couple exerted by the bifilar suspension for any angle is supposed to have been determined by experiment, a relation between the value of H and the value of the current is obtained. But, as the same current is sent through the coil of the standard galvanometer, the observed deflection of the needle of that instrument gives another relation between H and C. From the two equations expressing these relations the values of H and C can be found. Full details of the construction of Kohlrausch's apparatus and of the calculation of its constants will be found in the paper above referred to.

In this method it is assumed that the value of H is the same at both instruments, an assumption which for rooms not specially constructed for magnetic experiments cannot safely be made. An instrument which is not liable to this objection has been suggested by Sir William Thomson. A short account of this instrument and its theory will be found in Maxwell's "Electricity and Magnetism," vol. ii. p. 328.

In the application of what has gone before to the graduation of galvanometers, we shall have to deal with the quantities resistance and potential, and in our calculations to measure potentials in volts, resistances in ohms, and currents in amperes. A full explanation of the terms resistance and potential would require a treatise on electricity, but perhaps a very short explanation of what is meant by a volt, by an ohm, and by an ampere may not be here out of place.

Two conductors are at different potentials when, on their being put in contact, electricity passes from one to the other. The difference of potential between them will be made manifest if one of them be connected with an electrically insulated plate which forms one of the scales of a delicate balance, and the other with a second insulated plate parallel to, and at a very small distance from the first plate. If the conductors be at different potentials the plates will attract one another, and the force of attraction may be weighed by means of the balance. With certain arrangements to ensure accuracy, a balance may be constructed by means of which the difference of potentials between two conductors can be measured. Such an instrument has been made by Sir William Thomson, and called by him an Absolute Electrometer.

[1] Continued from p. 108.